

U. S. Geological Survey Invasive Species Program

Significant Accomplishments in FY 2001 and Proposed Activities in FY 2002

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BIOLOGICAL RESEARCH:
Invasive Species Program Area (FY 2001 - \$7.6M)

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Alaska Science Center, Anchorage, AK

The Alaska Science Center (ASC) plays a pivotal role in conducting research on fish, wildlife, and their vast habitats in Alaska. Nearly 88% of all National Wildlife Refuges and 65% of all National Park lands are in Alaska. ASC is responsible for research on the Department of Interior trust lands, waters, and species in Alaska, and provides scientific information essential for resource management decisions.

Alaska's National Parks have few invasive species compared to National Park units in other states. Therefore, the primary objective of the ASC's invasive species project is to assist the National Park Service in maintaining this relatively pristine gene pool, and to provide early detection and rapid response capabilities when new invaders are observed.

Survey and Identification of Invasive Plants in Alaskan National Parks. In FY 2001, ASC continued its on-going project to detect exotic plants in Alaskan national park units. Surveys continued in five parks: Denali National Park and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park and Preserve, Sitka National Historical Park, and Wrangell-St. Elias National Park and Preserve. The data have been entered into a database, which includes the location and size of each exotic plant population. In FY 2001, the survey found 33 exotic plant taxa, ten of which had not previously been reported in Alaskan parks. Two species, white sweetclover (*Melilotus alba*) and hawksbeard (*Crepis tectorum*), have recently invaded Denali National Park on vehicle tires and have spread rapidly. The FY 2001 report includes 24 subreports containing information on individual exotic species for each park in which the species was found. Each subreport provides ecological data; assesses the current level of impact, species invasiveness, and feasibility of control; and recommends monitoring and management methods for each park. (NISMP 46c)

In FY 2002, ASC will initiate research on methods to control selected invasive species and will expand the detection effort to additional parks.

ASC also released the final version of a monograph on re-vegetation with native plants in Denali National Park and Preserve. The manual includes data on re-vegetation methods that effectively excluded invasive plants.

Columbia Environmental Research Center, Columbia, MO

The Columbia Environmental Research Center (CERC) provides scientific information and methodologies for addressing national and international environmental contaminant issues, and assessing the ecological effects of toxic substances and habitat alterations, with emphasis on large-river floodplains, coastal habitats, wetlands, and lakes. As a national leader in integrated research on aquatic ecosystems, CERC is currently investigating the impacts of a number of exotic invasive non-native fish including alewife, rainbow smelt, triploid grass carp, and black carp.

Biology and Impacts of Rainbow Smelt. In 2001, CERC continued to assess the possible effects of the invasive rainbow smelt on aquatic ecosystems in Voyageurs National Park. Areas being investigated include types of habitat preferred by smelt, predation of smelt on other fish species and native invertebrates, and predation by other fish species such as walleye and northern pike on smelt. In 2002, CERC will continue these investigations and use hydroacoustic sample and midwater trawling to estimate the productivity of rainbow smelt, as well as fish species with which they may be interacting. (NISMP 46)

Alewife and Smelt in the Great Lakes. Early Mortality Syndrome (EMS) is a disease that is currently being observed in swim-up fry of Great Lakes trout, rainbow trout, coho salmon, and chinook salmon. The severity of the disease in certain populations of Great Lakes salmonids threatens their ability to sustain themselves. Currently, it is thought that EMS is caused by a thiamine (vitamin B1) deficiency in the developing embryo. In part, the origin of the thiamine deficiency is thought to be bacteria containing the enzyme, thiaminase, in forage fish, such as introduced alewives and smelt. CERC is investigating the mechanisms of thiamine deficiency and its importance to the native salmonids of the Great Lakes. In 2002, CERC scientists plan to continue their study of this problem, and will be looking for a cause and effect relationship between thiaminase-containing bacteria in alewife and smelt, and EMS in native salmonids.

Reproductive Potential of Triploid Grass Carp and Black Carp. During the past several decades, triploid (sterile) and diploid (fertile) grass carp have been produced and stocked throughout the Mississippi River basin to control aquatic invasive plants, and have established self-sustaining populations in some areas. In recent years, triploid black carp have been proposed as a solution to parasitic trematode problems affecting fish production in aquaculture. In spite of technological advances in inducing triploidy (i.e., the formation of an extra set of chromosomes that prevents sexual reproduction) in carp fry, some researchers have suggested that some triploid individuals of these species may not be completely sterile and may be capable of producing fertile (diploid) offspring. Ongoing CERC research is evaluating the reproductive potential of triploid, diploid, and back crosses of grass and black carp to determine the threat that their accidental or intentional introduction may pose to native fish populations. Information from the study will help determine the utility and safety of using triploid carp as biological control agents in controlling aquatic invasive plants, and in controlling parasitic trematode problems in the aquaculture industry. (NISMP 46e)

Florida Caribbean Science Center, Gainesville, FL

The Florida Caribbean Science Center (FCSC) researches and disseminates information on aquatic invasive species and other non-indigenous animals and plants. Goals of the FCSC non-indigenous species program are: 1) to document the distribution, abundance, and dispersal of introduced organisms; 2) to conduct field and laboratory studies on ecology to document effects of introductions; 3) to analyze life history attributes in order to identify potential management and control measures; 4) to assess the risks of current and proposed introductions, and 5) to support the DOI mission, USGS programs, and the South Florida Restoration effort.

In particular, FCSC scientists play a special role in public education and outreach, as they are called upon hundreds of times each year to provide positive identification of exotic fishes and plants, for information on occurrence verification, distribution maps and inventories, and for presentations at professional and public meetings.

FCSC Documents New Aquatic Invasive Species. In FY 2001, a scientist at FCSC documented the occurrence of a new invasive species in North America, the green mussel. The resulting paper was the first accepted for publication on this new species in North America. Work on the green mussel will continue in FY 2002 via an EPA STAR Grant coordinated with the University of Florida. Another researcher provided taxonomic analysis and determination of three new aquatic plant taxa in southeastern states. The work resulted in a web-based identification and biological information on water clover, and alert flyers, web-based maps and identification for Wright's nut-rush. (*NISMP 21*)

Non-indigenous Aquatic Species Database. The FCSC maintains the Non-indigenous Aquatic Species (NAS) Database, which serves as repository for information on the distribution of exotic aquatic species, many of which are considered to be invasive. Much of the information in the database can be accessed over the Internet in real-time queries at <http://nas.er.usgs.gov>. The NAS website receives thousands of hits each month. Under a new Memorandum of Understanding, the USGS and the Smithsonian Institution are linking the NAS database with SI's Ballast Water Clearinghouse, which provides information on ballast water as a key pathway for introducing aquatic invaders. (*NISMP 21d, 51b*)

Also in FY 2001, the FCSC was awarded the first installment of USDA/IFAFS grant for continuation and advancement of a Geographic Information System to track the invasive plant, giant salvinia. An updated risk assessment project on the invasive Asian black carp was completed for the U.S. Fish and Wildlife Service and the Aquatic Nuisance Species Task Force.

FY 2002 will see a continuation of activity on the NAS Database. Other new projects include:

- A risk assessment of invasive Asian swamp eels in the United States, including research to evaluate ecosystem-level effects and control methods (*NISMP 46d, 46e*)
- An initiative to research the ecophysiology of the invasive sedge Wright's nut-rush (*Scleria lacustris*) in conservation marshes of Florida
- A study of the behavioral interactions between the non-indigenous red shiner and the threatened blue shiner in the southern Appalachians (*NISMP 46c*)
- A risk assessment on snakeheads (foreign fishes recently introduced and established in Florida)

Forest and Rangeland Ecosystem Science Center, Corvallis, OR

Invasive species threaten millions of acres of terrestrial and aquatic ecosystems in the western United States. They reduce the economic potential of these areas by decreasing forage and habitat for livestock and wildlife, impact recreational opportunities, and threaten the natural environment of public lands. The Forest & Rangeland Ecosystem Science Center (FRESC) collaborates with university and federal research scientists and state and federal land managers to develop research on major invasive species problems. Current emphasis is on the effects of invasive plants on arid and semiarid ecosystems, and of invasive fish and frogs on native amphibians in lakes, ponds and wetlands.

Coordinated Intermountain Restoration Project: Cheatgrass Control. Rangelands throughout the Great Basin and Snake River Plateau are threatened by the continued spread of invasive exotic annual grasses, such as cheatgrass, and loss of native plants. Partnering with BLM, USDA (NRCS, ARS), University of Nevada Reno, Oregon State University, Utah State University and Boise State University, FRESC scientists have examined the impacts of cheatgrass on the nutrient cycling of cheatgrass-dominated ecosystems. In FY 2002, FRESC is initiating studies on livestock grazing, prescribed fire, and the effectiveness of the herbicide "Plateau" on cheatgrass control and its effects on native species. (NISMP 43)

Non-Native Fish Assist Exotic Bullfrog Invasion. Bullfrogs, which are detrimental to a variety of native fauna and are a factor in some amphibian declines, are invading most permanent ponds in western North America. FRESC scientists have demonstrated that non-native fish are facilitating the invasion of bullfrogs. This is the first time a non-native animal has been shown to facilitate the invasion of another non-native animal. This finding helps explain how the rate of invasions can increase in some areas and suggests that controlling non-native fish might help control bullfrogs. EPA, the Oregon Department of Fish and Wildlife, and other agencies are partners. (NISMP 46)

Predicting Ecosystem Vulnerability to Cheatgrass Invasion. The invasive plant cheatgrass is dominating many plant communities of the western U.S. FRESC scientists developed methods to predict habitat susceptibility to cheatgrass invasion and reduce cheatgrass emergence based on site characteristics. Currently, fire and fertilizer treatments are being tested to reduce cheatgrass establishment and performance without affecting native grasses. (NISMP 43)

Invasive Aquatic Animals: A Role in Amphibian Decline? Invasive animals, including bullfrogs, crayfish, and a variety of fish, are impacting the majority of permanent ponds and lakes in western North America and are uniformly cited as factors in amphibian declines. However, FRESC researchers have found that not all amphibians are negatively affected by introduced animals. Hydrological changes may simultaneously diminish native amphibians while facilitating invasive animals, thus giving the erroneous appearance that invasives are displacing native species. Partners include the NPS, BLM, USFWS, EPA, and state agencies. (NISMP 46)

Other on-going projects at FRESC include:

- Recovery of salamander populations in high-mountain lakes after trout removal, Mount Rainier National Park, Washington
- The influence of introduced fish on the threatened Oregon spotted frog, Cascade Range (NISMP 46c)

Great Lakes Science Center, Ann Arbor, MI

The Great Lakes Science Center (GLSC) conducts a combination of field, laboratory, and modeling studies to provide information pertinent to prevention, containment, and control of invasive species. More than 160 invasive species have been documented in Great Lakes aquatic and wetland communities with many more known on lands throughout the watershed. Economic losses because of invasive species, such as the sea lamprey and zebra mussel, are in the tens of million of dollars annually.

GLSC Discovers New Non-Native Aquatic Animals. GLSC scientists discovered two new species of bottom-dwelling non-native animals (copepod crustaceans) from the near shore sands of southern Lake Michigan. Both are thought to be of marine origin, likely introduced in ballast water discharges from ocean-going vessels, and one is probably new to science. These exotics have already become the numerically dominant crustaceans in the shallow sands investigated. In addition, GLSC scientists discovered a parasitic copepod that is native to eastern Asia on 11 species of fish in Lake Huron. This parasitic copepod was probably introduced into the Great Lakes on exotic fish hosts associated with the aquaculture industry. (NISMP 21)

Fish Population Assessments Aid Native Lake Trout Recovery. GLSC and the New York Department of Environmental Conservation (NYDEC) conduct annual population assessments of stocked native lake trout and their prey, the invasive alewives and rainbow smelt. The introduction and build-up of zebra mussels near shore caused the three fish species to move to deeper waters. However, stocked lake trout fry continued to be released into shallow waters. Research showing plummeting survival of hatchery-reared lake trout fry, combined with the knowledge that prey fish were scarce near shore, prompted managers to stock the fry from barges off shore where abundant prey fish would buffer the stocked trout fry from predation. Although the level of trout reproductive success is currently insufficient to maintain the spawning stock, this change in fishery management practices, based on GLSC research efforts, is an important milestone towards the goal of restoring a self-sustaining population. (NISMP 46e)

Invasive Fish and Mussels Impact Native Species Survival. Populations of endangered lake sturgeon have been showing signs of recovery in recent years, but new GLSC studies are underway on the effects of round goby predation on lake sturgeon eggs. Food habits of the round goby are being investigated in Lakes Michigan and Huron, with special concern about competition of this invasive species with native darters and sculpins. Research is also underway in Lake Ontario on the deepwater amphipod, *Diporeia*, that has declined coincident with zebra and quagga mussel increases. *Diporeia* is an important food source for many species of native fishes. (NISMP 46c)

Integrated Pest Management Controls Sea Lampreys. Current studies by GLSC in cooperation with the Great Lakes Fishery Commission to control sea lampreys include new technology to block spawning migrations, assessment of the effectiveness of lampricides at reduced concentrations, description of bathothermal habitat selection of sea lampreys and their hosts, and description of how sea lampreys use a migratory pheromone to select spawning streams. The Sea Lamprey Management Program is one of the few examples of a successful integrated pest management approach to control an aquatic, invasive species. (NISMP 44)

Additional GLSC projects include:

- Research to aid construction of an invasive species barrier between the Great Lakes and the Mississippi River basin. (*NISMP 46e*)
- An analysis of invasive exotic plants within three Great Lakes National Parks based on land use, distance from roads, and habitat types. (*NISMP 46c*)

Leetown Science Center, Leetown, WV

Invasive species research at the Leetown Science Center (LSC) was initiated in FY 1998 under the Exotics in the East program with both long-term projects (5 years) and a number of shorter-term exploratory projects. The first funding cycle of projects will end in FY 2002 and a new series of investigations will begin in FY 2003. LSC's current research has focused on three areas: 1) early detection and assessment, 2) ecological effects and 3) new methods for control. Major on-going projects highlighted below are addressing these issues through FY 2002.

Assessment of Hemlock Woolly Adelgid Damage on Federal Lands. Ecologists at LSC are using landscape and biotic-assessment techniques to determine risks of biodiversity loss in hemlock ecosystems due to the hemlock woolly adelgid (HWA). This exotic aphid-like insect, native to Japan, causes defoliation of hemlocks and poses a severe threat to several native species of insect-eating birds. By developing predictive landscape models, scientists and resource managers at parks and national forests can then use the models to predict losses of bird species in their parks. (NISMP 46e)

Exotic Fish Threaten Native Freshwater Mussels. LSC scientists are studying the impact of exotic fish on the distribution of native fish that serve as hosts in the reproductive process of native freshwater mussels. This cooperative project with the National Park Service will provide information on which exotic fish species pose the greatest threat to native mussel populations in the northeastern United States. LSC has completed a continuous qualitative mussel survey of the entire 125-mile stretch of the mainstream Delaware River under management by the National Park Service. This dataset for freshwater mussels will be used to determine macro-habitat and land use impacts on mussel distribution. (NISMP 46c)

Control of Zebra Mussels and Asian Clams. Zebra mussels and Asian clams are invasive aquatic species that are causing major fouling of water intake structures and are threatening populations of native freshwater mussels. Their rapid spread has created the need for new cost-effective methods for control. An experimental technology being tested at LSC involves continuous or intermittent exposure of invasive mussels to supersaturated concentrations of carbon dioxide, air, stack gas, or a mixture of these gases. Pilot scale tests will demonstrate application of the control process and establish relative treatment costs. (NISMP 46e)

Other on-going projects include:

- Genetic research to assist in managing native Atlantic salmon stocks. Atlantic salmon restoration in Northeastern Rivers is potentially threatened by the introduction of evolutionary divergent non-native Atlantic salmon stocks. The mixing of these genetic stocks may create problems, including the loss of local genetic adaptations and the spread of exotic pathogens.
- Development of an Internet-based data entry and information delivery system for invasive species in cooperation with the state of Delaware. The system will encourage broad contribution of data on the location of invasive species throughout Delaware, and facilitate and increase access to geospatial data on the status and distribution of these species.

Midcontinent Ecological Science Center, Fort Collins, CO

The Midcontinent Ecological Science Center's (MESC) work on invasive species focuses primarily on development of methods for survey, monitoring, and assessment of terrestrial plant and animal invaders, predicting their probable impacts on vulnerable habitats, and providing information and practical approaches to support prevention and control strategies on public lands, with particular emphasis on mid-continent forests and grasslands. Herpetologists at the MESC play a leading role in cooperative research on the brown tree snake, which has devastated the native fauna of Guam and other Pacific Islands. MESC also conducts economic and sociological research relating to biological invasions.

Rapid Assessment and Control of Plant Invaders on Public Lands. In cooperation with Colorado State University, MESC scientists developed multi-scale sampling techniques and new predictive models for rapid assessment of non-native plants species on DOI lands, including Rocky Mountain National Park in Colorado and the Grand Staircase – Escalante National Monument in Utah. The techniques combine remote sensing, nested-scale sampling plots, and predictive modeling to enable managers to assess current patterns, potential distributions, and probabilities of invasions by particular species for use in decisions on the most cost-efficient management responses. Scientific publications from the project underscore the wide applicability of the methods and modeling approaches in managing plant invasions on conservation lands. In FY 2002, research will be expanded to assess invasions in National Wildlife Refuges. (*NISMP 21c, 50, 51a*)

MESC research in FY 2001 assessed the impacts and effectiveness of control methods for particularly noxious weeds on DOI lands. Projects in Colorado and Nevada determined the response of riparian vegetation following application of “Garlon 4” herbicide as an alternative to biological control for saltcedar. As part of interagency efforts to control the rapid spread of giant salvinia, a highly invasive floating aquatic fern, two USGS centers cooperated in research which determined the sensitivity of this plant to the herbicide “Rodeo” and five surfactants under controlled conditions. Field testing of these chemical applications will continue in FY 2002 in cooperation with the U.S. Army Corps of Engineers in Texas.

USGS Research Controls Brown Tree Snakes. In FY 2001, USGS hosted the Brown Tree Snake Research and Management Conference in Guam, which reviewed the results of recent research on the species' biology and its implications for prevention and control. Research has clarified likely places on aircraft for stowaway snakes, thereby improving efficiency of inspections. The USGS design for a concrete barrier around ports, now proven 100% effective at preventing breaches by snakes, will be used at the Guam International Airport. An effective, inexpensive, and simple method for sterilizing male brown tree snakes was developed, which will facilitate the training of dogs to detect and prevent population establishment on snake-free islands. Additional research has clarified how the snake's prey preference changes with age, which will improve trapping effectiveness for snakes of all ages. Continuing research is directed at developing better ways to capture snakes of various sizes and under different prey densities. (*NISMP 21c, 46e*)

Plant Invasions Lessened by Reducing Wildfire Fuel. MESC, in cooperation with the Western Fire Research Center and Colorado State University, initiated a three-year study of spatial interactions among fuels, wildfire, and invasive plants for the Cerro Grande Burn, Los Alamos, NM to support integrated fire management strategies. FY 2001 results suggest that the most severe

burns had the most extensive plant invasions; that areas where fuels were reduced before the fire by thinning and prescribed burning had the least extensive plant invasions; and that ponderosa pine stands receiving no pre-fire treatment were most susceptible to plant invasions. The team is developing predictive maps of invasive species distributions, and will begin research on the Hi Meadow Burn, in Bailey, Colorado in 2002. In a related project, MESC is working with other USGS disciplines to assess the ecological, hydrological, and geological effects of burn severity in the New Mexico and Colorado burns, and how these effects influence resource users and human communities. (NISMP 46d)

Ecology of Invasive Trees in Riparian Zones. In 2001, field data collection was completed for a regional study of woody riparian vegetation associated with 500 long-term gage sites in 17 western state to determine environmental factors (including flow regime) influencing distributions of native and non-native riparian trees. The project provides essential data for predicting the vulnerability of riparian areas to invasive tree species. In the Colorado River Basin, research was initiated to determine how invasion by saltcedar influences long-term development of riparian vegetation. The project will help managers establish realistic objectives for vegetation management. (NISMP 46d)

MESC continued translating literature on Eurasian riparian systems (source of our most aggressive riparian invaders) in order to provide additional information for use in predicting their spread and dynamics in U.S. habitats. Preliminary results of collaborative research on the ecology of saltcedar and Russian olive in western North America and Central Asia were presented at the U.S. - Russia Invasive Species Workshop in Borok, Russia (co-sponsored by USGS and the Russian Academy of Sciences). These activities will continue in FY 2002. (NISMP 44)

National Wetlands Research Center, Lafayette, LA

The USGS National Wetlands Research Center's (NWRC) mission is to develop and disseminate the scientific information needed to understand wetland and coastal ecology, as well as manage and restore our nation's wetland habitats. Invasive plants and animals have been recognized as playing a large part in the loss of wetland and coastal habitats. Along with the projects detailed below, NWRC has been active in researching the impacts of exotic grasses on native plants, surveying the Gulf of Mexico for invasive aquatic plants, and investigating the interactions between wild land fires and exotic invasive plants.

Ecology, Management, and Control of Chinese Tallow in Coastal Prairie. NWRC scientists teamed with USFWS refuge managers to conduct prescribed burns in the rare coastal prairie communities of Texas and Louisiana to control an exotic tree species, Chinese tallow. The USFWS refuge managers spend increasing amounts of time and money trying to control this species. By investigating the effects of burning on the survival and growth of these invasive species, researchers were able to show that effects of fire on Chinese tallow are size- and age-dependent, allowing refuge managers to focus their management dollars and labor effectively. An additional component of this work has been conducted in conjunction with researchers at Rice University and supported by the USEPA to look at the potential for fire to affect the initial colonization of prairie by Chinese tallow. (NISMP 46e)

Satellite Mapping of the Distribution of the Exotic Tree, Chinese Tallow. NWRC initiated a collaborative study with NASA for mapping Chinese tallow with EO-1 Hyperspectral and Landsat 7 Enhanced Thematic Mapper data. This invasive tree is currently widespread and actively advancing inland in the south and southeast and along arid riparian areas of the south and southwest. It is causing extensive damage by displacing native communities and creating biological deserts. The mapping technique relies on unique bright red color of the Chinese tallow foliage in the fall. With better maps, land managers can specifically target Chinese tallow trees for removal. (NISMP 46c)

Impacts of the Exotic Mammal, Nutria, on Coastal Marsh Habitats. Scientists at NWRC conducted field experiments to ascertain the potential impact of nutria on marsh habitat. The results of this study were presented at the national meeting of the Ecological Society of America as well as in the *Wildlife Society Bulletin*. (NISMP 46d)

In FY 2002, in addition to continuing the above-described studies, NWRC, with support from USFWS, will to conduct a survey and assessment of threats from invasive species for Texas coastal ecosystems. NWRC will also participate in a symposium on fire and invasive plants that has been proposed for the 2002 Annual Meeting of the Ecological Society of America.

National Wildlife Health Center, Madison, WI

The National Wildlife Health Center (NWHC) was created in 1975 in response to the emergence of new wildlife diseases and the re-emergence of previously conquered diseases. NWHC collects and disseminates information and conducts research on the epidemiology and ecology of wildlife diseases, and provides technical assistance to domestic and international wildlife agencies in diagnosis and response to wildlife diseases.

Increasing Preparedness through Better Understanding of the Relationships between Foot and Mouth Disease and Native Wildlife. USGS provided expert perspective to a Department of the Interior Task Force on Foot and Mouth Disease (FMD) regarding threats to wildlife and the potential role of wildlife in the spread of foot and mouth disease, which has caused devastating impacts to the domestic livestock industry in Europe. As a part of this effort, USGS established productive associations with USDA and other DOI Bureaus, provided the latest information on FMD to policy makers and congressional staff, and initiated collaborations with international experts to plan proposed studies during the coming year. All species of wild ungulates in the United States are susceptible to FMD and there is little information to predict the fate of animals once they are infected with the virus. Planned experiments in FY 2002 will expose bison, elk, and pronghorn antelope, as well as several species of birds to FMD to establish the results of infection with the virus. Additional experiments will be conducted to detect avenues of transmission of the virus within species and between species (to livestock). Information gathered from this research will be used to manage wildlife should a disease outbreak occur in the United States. *(NISMP 21b)*

West Nile Virus: Surveillance and Development of Vaccine. The USGS National Wildlife Health Center (NWHC) continues to provide diagnostic support to local, state, and Federal agencies (such as public health and wildlife organizations) by receiving wildlife carcasses, tissues, or serum to attempt detection of West Nile Virus (WNV). Active surveillance to detect the geographic expansion of the virus by sampling free-ranging wild birds is on-going in collaboration with the U.S. Department of Agriculture, U.S. Fish and Wildlife Service, and several state wildlife agencies. In 2001, the NWHC began a research effort in collaboration with USGS Mapping and the Centers for Disease Control (CDC) to investigate the role of migratory birds in disseminating the virus and to investigate pathways for WNV maintenance and transmission. Studies have demonstrated successful bird-to-bird and oral transmission of the disease. The efficacy of a commercial killed-virus WNV vaccine has been evaluated in crows, and will next be tested on sandhill cranes. *(NISMP 21b)*

Other FY 2001 projects that will continue into FY 2002 at NWHC include:

- A study of an exotic parasite, introduced from Eastern Europe, which causes large-scale mortality in American coots. Work in future years (if funded) will focus on controlling the snail that serves as intermediate host of this parasite and preventing the parasite's spread. *(NISMP 46)*
- An investigation of fish parasites of the Lower Little Colorado River in the Grand Canyon. Results to date show that exotic parasites, brought by non-native fish, threaten the survival of the endangered humpback chub. These data can be used to manage water temperature and flow from the Glen Canyon dam to slow parasite dispersal and effect. *(NISMP 46)*

Northern Prairie Wildlife Research Center, Jamestown, ND

The Northern Prairie Wildlife Research Center's (NPWRC) mission is to study the biological resources of the nation's interior grasslands, and provide information needed by decision-makers to assess and predict the consequences of various policies and management practices. As a part of this mission, NPWRC's scientists conduct projects on all aspects of grassland ecology, including birds, mammals, plants, invertebrates, and amphibians, as well as disturbance ecology, prairie restoration, and control of invasive species.

Effects of Leafy Spurge Infestation On Pollination of Native Prairie Plants. The scent of nectar and the sound of bees increase dramatically in a patch of leafy spurge, compared with surrounding native prairie. This observation led to the hypothesis that spurge infestations may affect pollination of native flowering plants. A NPWRC pilot study in 1997 found that spurge pollen is being transferred to the stigmas of the native plant, *Linum perenne*, with the potential for negative effects on seed set. Work is continuing with new funding for FY 2002 to more thoroughly investigate the breadth of the phenomenon and the likelihood for population-level effects. (NISMP 46d)

Horse Trails As Pathways of Exotic Species Invasions at Ozark National Scenic Riverways. Over the last ten years, horseback riding has become one of the most popular activities at Ozark National Scenic Riverways (OZAR). This two-year research project begun in FY 2000 investigates exotic species frequency, cover and richness along horse trails, abandoned roads, and undisturbed sites in six native vegetation community types in OZAR. Preliminary findings indicate that horse trail sites support a greater frequency and variety of exotic plants. Nine of the fifteen exotic species encountered occurred only along horse trails. Therefore, management actions can be tailored to focus on these pathways. Analysis continues into FY 2002. (NISMP 46c)

Effects of Leafy Spurge Infestation on Breeding Birds of the Sheyenne National Grassland, ND. NPWRC scientists examined the effects of a leafy spurge (*Euphorbia esula*) infestation on nest densities and nest success of breeding birds in grasslands on the Sheyenne National Grassland, ND. Based on the data collected, it was determined that some bird species were present in higher densities on low-spurge sites versus high-spurge sites. It is possible that spurge changes the vegetation structure of the grassland, to the detriment of grassland bird foraging and nesting. (NISMP 46c)

Other projects continuing in FY 2002 include:

- Experimental treatment for leafy spurge infestations at Arrowwood and Tewaukon National Wildlife Refuges and experimental treatment for Canada thistle infestations at Lake Andes and Lacreek National Wildlife Refuges using soil nutrient manipulation and biocontrol agents (NISMP 46e)
- An investigation of the role of yellow sweetclover (*Melilotus officinalis*) in successional changes in plant communities at Badlands National Park, SD (NISMP 46d)
- A study of the effects of reed canary grass invasion on breeding birds at Squaw Creek and Swan Lake National Wildlife Refuges (new in FY 2002) (NISMP 46c)

Pacific Island Ecosystems Research Center, Honolulu, HI

Because of the evolution of their unique plants and animals in isolation, Hawaii and the Pacific Islands are much more vulnerable to invasions than most places in the U.S. More native species have been eliminated in Hawaii than anywhere else in the United States. And, although habitat destruction has been an important cause of extinction and endangerment, the introduction of invasive alien species is now the predominant cause of biodiversity loss in Hawaii. Other Pacific Islands, with less international commerce, have suffered less to date, but have much to lose. Almost all of the Pacific Island Ecosystems Research Center's (PIERC) work involves invasive species directly or indirectly, with the aim of protecting federally important resources, national parks and endangered species in Hawaii and the Pacific.

Mapping Efforts Lead To Eradication of Invasive Species on Maui. PIERC mapped distributions of over 100 incipient plant invaders on the island of Maui and part of the island of Hawaii. The interagency Maui Invasive Species Committee (MISC) used the information to eradicate three serious incipient plant invaders from the island of Maui. For FY 2002, PIERC would like to expand mapping of invasive plant species to the entire island of Hawaii and to Molokai. MISC and the National Park Service weed management team continue removal efforts and are close to eradicating PIERC-mapped populations of three other invasive plants. (NISMP 46)

Plan Completed to Prevent Red Imported Fire Ants in Hawaii. PIERC led efforts to complete an interagency plan to prevent establishment of the Red Imported Fire Ant (*Solenopsis invicta*). Of all potential invasive species, the RIFA seems to pose the most immediate and obvious threat -- not only to biodiversity, but also to human and animal health, the economy, and quality-of-life in Hawaii. Recently established in Australia, New Zealand, and California (and notoriously difficult to eradicate once established), a RIFA invasion of Hawaii appears imminent due to the huge quantities of goods shipped to Hawaii from California. In FY 2002, PIERC will undertake an EPA-funded RIFA economic study and educational outreach program. (NISMP 17, 21c)

PIERC Assists National Park of American Samoa. PIERC researchers assisted the National Park of American Samoa (NPAS) by surveying for avian disease and invasive plants. Because NPAS has no avian disease and few invasive plants to date, PIERC scientists recommended that the new interagency American Samoa Invasive Species Committee prioritize the prevention of new invasions and respond quickly to selected incipient invasions.

Other accomplishments and on-going projects at PIERC include:

- Biocontrol research on five invasive plants, with emphasis for FY 2002 on biocontrol of *Miconia calvescens*. (NISMP 46e)
- PIERC participation in the creation of the Pacific Basin Information Node (PBIN) of the National Biological Information Infrastructure (NBII), with FY 2002 efforts on the establishment of an interagency early warning system for prevention and rapid response for invasive species in the Pacific Islands. (NISMP 46)
- PIERC sponsored the Annual Meeting of the Society for Conservation Biology in Hilo, Hawaii, on 29 July through 1 August 2001.
- The writing of the monograph, "Forest Birds of Hawaii," led by a PIERC scientist, will be completed in FY 2002.

Patuxent Wildlife Research Center, Laurel, MD

The Patuxent Wildlife Research Center's (PWRC) emphasis is on monitoring the status and trends of wildlife populations, restoring and maintaining wetlands and other ecological systems, and assessing the effects of natural and human impacts on biological resources. A core research focus is on the population biology and dynamics of migratory birds. Current research on invasive species focuses on the National Capitol and mid-Atlantic region.

Management and Control of Lesser Celandine (*Ranunculus ficaria*) in Rock Creek Park, Washington, DC. FY 2001 saw completion of the second year of a three-year project, conducted for and in cooperation with the National Park Service, designed to control the invasive plant lesser celandine in Rock Creek Park. PWRC researchers completed a suite of treatments using a range of concentrations of the herbicide "Rodeo" to selectively control *R. ficaria* before other species emerged in the spring. The project will continue in FY 2002, and will present a scientifically-determined optimum treatment method to control lesser celandine and foster site restoration with native plants. (NISMP 46c)

Restoration of Vegetation of Kingman Marsh, Washington, DC. PWRC is working closely with the Army Corps of Engineers and other agencies on wetland restoration work, using native species for wetland establishment in the Anacostia River in Washington, D.C. In FY 2001, USGS scientists studying the restoration efforts noted that resident Canada geese are behaving as an invasive species, impeding wetland reconstruction activities by browsing the native plants used in restoring the freshwater tidal wetlands. Restoration and monitoring work will continue in FY 2002. (NISMP 46e)

West Nile Virus Surveillance and Management. PWRC scientists have assisted several National Parks in setting up surveillance and management programs for mosquitoes and West Nile Virus (WNV), including one for Gateway National Recreation Area in New York and New Jersey. These plans use surveillance data to promote efficient management of vectors (mosquitos, birds) that might pose a human health risk, so that the park can protect public health while minimizing any negative effects on park natural resources. This project was coordinated with the WNV programs of New York City, Monmouth Co., NJ, Suffolk Co., NY, and the Centers for Disease Control. In FY 2002, the work continues with a research project for the National Park Service, which will look at mosquito distribution and infection with WNV, mosquito surveillance methods, and the transmission cycle of WNV in the eastern United States. (NISMP 21b)

Upper Midwest Environmental Sciences Center, La Crosse, WI

The USGS Upper Midwest Environmental Sciences Center's (UMESC) mission is to produce information needed for management of biological resources, with emphasis on the ecosystems of the northern Midwest. UMESC's core research programs focus on migratory birds, aquatic ecosystems, environmental contaminants, declining and endangered species, and fishery drug research and development, and include research on the effects of a number of invasive species.

Vulnerability of Upper Mississippi River Basin Habitats to Zebra Mussel Invasions. During the last decade, the zebra mussel has exacerbated the imperiled status of native freshwater mussels – already among the most endangered group of animals in North America. In FY 2001, UMESC, in collaboration with the U.S. Army Corps of Engineers, initiated a new project to conduct landscape analysis of freshwater mussels in the Upper Mississippi River Basin. By identifying river reaches less susceptible to zebra mussels, the project will help identify potential refuge areas for native mussels. (NISMP 46e)

Research to Support Control of Round Goby Invasions. Concern over the effects of round goby intrusion into the Illinois Waterway System from Lake Michigan via the Calumet drainage has led to efforts to monitor the species' spread in this system. Suggested control methods have included the use of chemical toxicants, but little information on the relative sensitivity of round goby to potential management chemicals exists. USGS toxicity tests indicated that round goby are sensitive to short exposures to the piscicides Bayluscide® and antimycin, and that these chemicals may have applications in controlling populations of round goby. The U.S. Fish and Wildlife Service, U.S. Corp of Army Engineers, and the U.S. Environmental Protection Agency provided reimbursable funding for this project. (NISMP 46e)

Other research accomplishments in FY 2001 include:

- Design of a new treatment model for chemical eradication of sea lamprey with no mortality among non-target fish. (NISMP 46e)
- Demonstration that certain fish toxicants and specific lampricides can be used to treat entire bodies of water for the purpose of repelling invasive European ruffe. (NISMP 46e)
- A Long Term Resource Monitoring Program, initiated by UMESC in 1989, continues to document the occurrence and distribution of exotic fishes in the Upper Mississippi River. Reports of new species occurrences in 2001 include the first collection of white perch in the Mississippi River (near St. Louis), and rudd (near Bellevue Iowa). The program documented the continued spread of aggressive invaders, including grass carp (collected since the beginning of the program) head carp (first collected in 1992), and silver carp (1998). (NISMP 46e)
- The Center's Grassland Birds Project identified reed canary grass as a potential threat to birds in wet meadows and grasslands, and intensive research on these effects was initiated. Preliminary results indicate the reed canary grass may have either positive or negative effects on native birds depending on the particular habitat and bird species. Research is continuing on the effects of reed canary grass invasions on wet meadow birds, several of which appear to avoid dense stands of the grass. (NISMP 46)

Western Ecological Research Center, Sacramento, CA

Under the USGS “Weeds in the West” initiative of 1998, the Western Ecological Research Center (WERC) began research that will improve the ability to detect, monitor, and predict the effects of invasive species in the Pacific Southwest – California, Nevada, Utah, and Arizona — a region characterized by remarkable biodiversity in an unparalleled range of environments. The projects address critical needs in California’s Central Valley, the Mojave and Sonoran deserts, selected national parks, and other sensitive areas in California and Arizona. This research provides resource managers with the information and tools needed to better understand and control invasive weeds on the land they manage and to help them avoid or prevent future invasions.

Cattle Grazing May Keep Exotic Plants at Bay. With more than a dozen cooperators, including the Cattlemen’s Association, WERC is testing the use of cattle grazing on the Lokern Natural Area in Western Kern County, CA to remove invasive grasses (*Bromus* spp.) in areas that provide habitat for endangered native plants, blunt-nosed leopard lizards, and several kangaroo rats. After four years of testing, the method shows promise for improving habitat. (NISMP 43)

Exotic Grasses Increase Fire Frequency in NE Mojave Desert, Harm Native Plants and Animals. WERC studies have shown that non-native annual grasses (*Bromus*, *Schismus*) now dominate most plant communities in the Mojave Desert. These grasses can create continuous fuel beds across the landscape, filling in the plant-free space that once separated and protected native perennials from fire. And unlike native annuals, which crumble and blow away soon after they die, dried remains of the nonnative grasses stay rooted in highly flammable dense stands for years after they die. This study also simulated the effects of air pollution dryfall of nitrogen on desert plants. The nitrogen caused exotic annual plants to grow dramatically, while native forbs declined. These results highlight the tremendously important link between air pollution from the densely-populated areas in southern California and growth of invasive species downwind. (NISMP 46d)

Other on-going and recent studies on invasive species in FY 2001 and FY 2002 include:

- A test to determine if a parasitic barnacle can be used as a biocontrol agent to control the European green crab without risk to native species (NISMP 46e)
- A study of the distribution and impact of perennial pepperweed on Central Valley national wildlife refuges (NISMP 46c)
- An investigation of how increased fire frequency from the spread of non-native plants and the effects of cattle grazing in the Mojave and Sonoran deserts are affecting native animals and plants such as the desert tortoise and saguaro cactus (NISMP 46c)
- An analysis of the distribution, abundance, and ecology of non-native plants in the Sierra Nevada national parks, southern Arizona national parks, and in Channel Islands National Park (NISMP 46c)
- A study of the biology of bullfrogs in California and in Arizona and their impacts as predators of rare native species (NISMP 46c)
- An inquiry into the ecological impacts of the African clawed frog in southern California (NISMP 46c)

Western Fisheries Research Center, Seattle, WA

The Western Fisheries Research Center (WFRC) carries out research and provides technical assistance to support the best possible stewardship of the nation's natural resources, emphasizing fish populations and aquatic ecosystems of the West. Research priorities include fish health, fish ecology, and aquatic ecosystems, and projects have focused on exotic fish pathogens, the interaction between invasive and native fish species, and, most recently, ballast water treatment.

West Coast Cooperative Research Program Launched to Help Prevent Invasive Species

Introductions in Ballast Water Discharges. (A new initiative in FY 2001 by Congressional add-on, \$500,000) Ballast water discharged in U.S. ports—which always contains live organisms—is a major source of foreign pathogens and nuisance aquatic species such as the zebra mussel. A single vessel can carry 22,000 tons of ballast water, and ballast water discharged to U.S. ports averages 40,000 gallons per minute around the clock. In FY 2001, the WFRC initiated a cooperative research program to help Federal, State, and local agencies and industry address this issue. WFRC assembled a consortium of nationally known scientists to respond to ballast water issues raised by managers. Specialized instrumentation (not commercially available) was constructed at WFRC's Marrowstone Marine Field Station in Washington State to help evaluate treatment technologies with laboratory-scale experiments. These studies are determining the range of physical and chemical conditions that affect survival/mortality rates of aquatic organisms found in ballast water. Initial experiments subjected a variety of aquatic organisms to varying intensities of ultraviolet light under highly controlled conditions, to help determine dose levels needed for effective treatment. Regulators are using results for the development of science-based standards and protocols for West Coast ballast water management programs. In response to further partner requests, USGS is working to develop capability for pilot-scale experiments so that industrial scale prototype treatment systems being developed by private industry can be tested at high flow volumes. Ongoing and planned research is an essential component of cooperative efforts to reduce risk of invasive species introductions on the West Coast through improved ballast water management. (NISMP 16)

Using Viral Pathogens As a Biocontrol for the Brown Tree Snake. A WFRC scientist made important initial steps in identifying viral pathogens that are highly virulent for brown tree snakes and that could substantially reduce the risk of the snakes spreading from Guam to other Pacific islands. The project was funded through the Smithsonian Institution by a grant from the U.S. Department of Defense (DOD) Legacy Program. This project's research phase ended in FY 2001, but several reports and publications resulting from the study will be finished in FY 2002. (NISMP 46e)

Symbiotic Fungi: Friends to Exotic Plants or a Novel Way to Control Them? Most, if not all, plants are known to be symbiotic with microscopic fungi. These fungi are important to the structure, function, and health of plant communities, and may confer benefits to plants such as drought tolerance, metal tolerance, enhanced growth, disease resistance, herbivore resistance and nutrient acquisition. WFRC research has shown that non-indigenous plants may transport non-indigenous fungi (which could act as a pathogen to native plants) or establish symbioses with native fungi (to gain mutualistic competitive benefits), thereby decreasing plant competition for the invaders. This research may result in novel and effective control strategies for invasive plant species by focusing on fungal symbionts rather than just the plants. (NISMP 46e)

National Biological Information Infrastructure

The National Biological Information Infrastructure (NBII) <<http://www.nbii.gov>> is a broad, collaborative program to provide increased access to data and information on the nation's biological resources. The NBII links diverse, high-quality biological databases, information products, and analytical tools maintained by NBII partners and other contributors in government agencies, academic institutions, non-government organizations, and private industry. NBII partners and collaborators also work on new standards, tools, and technologies that make it easier to find, integrate, and apply biological resources information.

Invasivespecies.gov Website Goes On-line. In FY 2001, NBII brought online the <<http://www.invasivespecies.gov>> Web site, the gateway to all federal efforts concerning invasive species. The Department of Agriculture's National Agriculture Library maintains the site for the National Invasive Species Council. NBII contributed funding towards site maintenance in FY 2001. (NISMP 47)

Three NBII Nodes To Focus on Invasive Species. Three regional NBII nodes with an emphasis on invasive species issues began development in FY 2001. (NISMP 46, 52)

- The Pacific Basin Information Node (PBIN) is initiating a project concerning identification and monitoring with the Bishop Museum and the Hawaii Natural Heritage Program. PBIN is also working with the Pacific Islands Ecological Research Center and the Hawaiian Ecosystems At Risk project to develop an informational database of key invasives and to use modeling to predict future pathways of spread.
- The NBII California Information Node (CAIN) is using supercomputing technology and XML to consolidate datasets on invasive species, especially weed species, and create applications designed to assist in decision-making concerning invasive species control. Partners include California Department of Fish & Game, University of California - Davis, UC- Santa Barbara, California Department of Food & Agriculture, University of Kansas, and others.
- NBII's Southern Appalachian Information Node (SAIN) is using technology available through the Oak Ridge National Laboratory and elsewhere to investigate the impact of invasive species in the Tennessee River Gorge. Other partners include the Universities of Tennessee at Chattanooga and Knoxville, Information International Associates, and SAMAB (Southern Appalachian Man and the Biosphere Program).

Federal funding for NBII nodes will remain at FY 2001 levels for FY 2002, with SAIN and PBIN each receiving an additional \$500,000 to continue their programs, including invasive species components. Each node will present specific project goals for FY 2002 at the NBII All-Node Meeting, in Davis, California, on January 29-31, 2002.

NBII funds Invasive Species Tools Node. NBII will contribute \$50,000 in funding in FY 2002 to a new cross-regional invasive species data synthesis effort called "One if by Land, Two if by Sea," based out of the USGS Midcontinent Environmental Science Center (MESC). MESC serves as the NBII Invasive Species Tools Node, and will make available information and decision support tools for documenting, mapping, and predicting the invasion of invasive species across the United States.